

AMENDMENTS TO THE CLAIMS

1. (Original) A tissue cutting device comprising:

an outer cannula defining an outer lumen and a tissue-receiving opening adjacent a distal end of said outer cannula communicating with said outer lumen;

an inner cannula slidably disposed within said outer lumen and defining a inner lumen from an open distal end to an open opposite proximal end, said inner cannula defining a cutting edge at said open distal end operable to sever tissue projecting through said tissue receiving opening;

C/6 a first hydraulic rotary motor operably coupled to said inner cannula to rotate said inner cannula within said outer cannula;

a second hydraulic reciprocating motor operably coupled to said inner cannula to translate said inner cannula within said outer cannula while said inner cannula rotates; and

a hydraulic system connecting said first and second hydraulic motors to a source of pressurized fluid.

2. (Withdrawn) A tissue cutting device comprising:

an outer cannula defining a tissue-receiving opening adjacent a distal end thereof;

an inner cannula slidably disposed within said outer cannula and defining a lumen from an open distal end to an open opposite proximal end, said inner cannula further defining a cutting edge at said open distal end;

a motor assembly operably coupled to said inner cannula for rotationally and reciprocatingly driving said inner cannula within said outer cannula; and

a cutting board disposed at said distal end of said outer cannula, said cutting board formed of a resilient plastic material having a hardness less than a hardness

of said inner cannula at said cutting edge but sufficient to substantially prevent permanent deformation of said cutting board under pressure from said cutting edge as said inner cannula rotates and reciprocates against said cutting board.

3. (Withdrawn) In a cannula sized for insertion in a human body, the cannula having a distal end and a proximal end and a substantially cylindrical outer wall defining a lumen along a longitudinal axis thereof, in which the lumen is sized to receive a movable cutting member therethrough, the improvement comprising an opening defined adjacent the distal end through the outer wall communicating with the lumen, said opening having opposite edges extending along the longitudinal axis, at least one of said edges defining at least one tooth arranged to engage tissue drawn into said opening when the cannula is inserted into a body.

C16 4. (Withdrawn) In a cannula sized for insertion in a human body, the cannula having a substantially cylindrical outer wall defining a lumen along a longitudinal axis thereof, in which the lumen is sized to receive a movable cutting member therethrough, the outer wall defining a lateral opening therethrough communicating with the lumen, the improvement comprising a stiffening member associated with the outer wall adjacent the lateral opening.

5. (Withdrawn) The improvement in a cannula according to claim 4, wherein said stiffening member includes a longitudinally extending rib defined in the outer wall.

6. (Withdrawn) The improvement in a cannula according to claim 5, wherein said rib is defined substantially diametrically opposite the lateral opening in the outer wall.

7. (Withdrawn) In a cannula sized for insertion in a human body, the cannula having a substantially cylindrical outer wall defining a lumen along a longitudinal axis thereof, in which the lumen is sized to receive a movable cutting member therethrough, the outer wall defining a lateral opening therethrough communicating with the lumen, the improvement comprising a dimple associated

with the outer wall and projecting into the lumen adjacent the lateral opening, said dimple sized to fit between the cutting member and the outer wall when the cutting member is within the lumen.

8. (Withdrawn) The improvement in a cannula according to claim 7, wherein said dimple is formed by a crimp in the outer wall of the cannula.

9. (Withdrawn) A tissue cutting device comprising:

an outer cannula defining an outer lumen and a tissue-receiving opening adjacent a distal end of said outer cannula communicating with said outer lumen;

C16 an inner cannula slidably disposed within said outer lumena defining an inner lumen from an open distal end to an open opposite proximal end, said inner cannula defining a cutting edge at said open distal end operable to sever tissue projecting through said tissue-receiving opening;

a first motor operably coupled to said inner cannula to move said inner cannula in a first direction within said outer lumen;

means for supporting said first motor for movement with said inner cannula in a second direction different from said first direction; and

a second motor operably coupled to said means for supporting to move said first motor, and thereby said inner cannula, in said second direction while said first motor moves said inner cannula in said first direction.

10. (Withdrawn) A tissue cutting device comprising:

an outer cannula defining an outer lumen between a distal end and an opposite proximal end, and further defining a tissue-receiving opening adjacent said distal end communicating with said lumen;

a cutting member slidably disposed within said outer lumen, said cutting member defining an inner lumen therethrough between a distal end and an

opposite proximal end, and further defining a cutting edge at said distal end of said cutting member;

a handpiece supporting a drive mechanism operably coupled to said cutting member to move said cutting edge across said tissue-receiving opening to sever tissue projecting therethrough;

a vacuum source in fluid communication with said proximal end of said cutting member; and

a hub having a distal end attached to said proximal end of said outer cannula, and a proximal end detachably mounted to said handpiece to permit separation of said outer cannula from said handpiece and said cutting member.

11. (Withdrawn) A tissue cutting device comprising:

C16 an outer cannula defining an outer lumen between a distal end and an opposite proximal end, and further defining a tissue-receiving opening adjacent said distal end communicating with said lumen;

a cutting member slidably disposed within said outer lumen, said cutting member defining an inner lumen therethrough between a distal end and an opposite proximal end, and further defining a cutting edge at said distal end of said cutting member;

a handpiece supporting a drive mechanism operably coupled to said cutting member to move said cutting edge past said tissue-receiving opening to sever tissue projecting therethrough;

a vacuum source in fluid communication with said inner lumen at said proximal end of said cutting member; and

a hub having a distal end attached to said proximal end of said outer cannula, and a proximal end mounted to said handpiece, said hub defining a leak path between said outer lumen of said outer cannula and atmospheric air when

said distal end of said outer cannula is disposed within a body and said hub is disposed outside the body.

12. (Withdrawn) A tissue cutting system comprising:

an outer cannula defining a tissue-receiving opening adjacent a distal end thereof;

an inner cannula slidably disposed within said outer cannula and defining a lumen from an open distal end to an open opposite proximal end, said inner cannula defining a cutting edge at said open distal end operable to sever tissue projecting through said tissue-receiving opening;

C16 a cutting board disposed at said distal end of said outer cannula distal from said tissue-receiving opening, said cutting board configured to conform to said cutting edge for impact cutting of tissue between said cutting edge and said cutting board;

a piston disposed within a hydraulic cylinder and operably coupled to said inner cannula to move said inner cannula within said outer cannula toward said cutting board;

a return spring disposed within said cylinder and operable against said piston to move said piston in a direction away from said cutting board;

a source of pressurized fluid connected to said hydraulic cylinder having a first state providing pressurized fluid to said cylinder and a second state permitting fluid to bleed from said cylinder; and

a pressure switch coupled to said source of pressurized fluid to switch said source between said first state and said second state as a function of the magnitude of fluid pressure within said cylinder.

13. (Withdrawn) A tissue cutting device comprising:

an outer cannula defining a tissue-receiving opening adjacent a distal end thereof;

an inner cannula slidably disposed within said outer cannula and defining a lumen from an open distal end to an open opposite proximal end, said inner cannula defining a cutting edge at said open distal end operable to sever tissue projecting through said tissue-receiving opening;

a cutting board disposed at said distal end of said outer cannula and cooperating with said cutting edge of said inner cannula to sever tissue under pressure from said cutting edge against said cutting board;

a hydraulic reciprocating motor operably coupled to said inner cannula to advance said inner cannula within said outer cannula against said cutting board; and

C16 a hydraulic system connecting said hydraulic motor to a source of pressurized fluid to provide a substantially constant fluid pressure to said motor as said motor advances said inner cannula.

2 14. (Withdrawn) The tissue cutting device of claim 1 further comprising a cutting board disposed at said distal end of said outer cannula.

3 15. (Withdrawn) The tissue cutting device of claim 14 wherein said cutting board is formed of a resilient plastic material having a hardness less than a hardness of said inner cannula at said cutting edge, but sufficient to substantially prevent permanent deformation of said cutting board under pressure from said cutting edge as said inner cannula rotates and reciprocates against said cutting board.

4 16. (Original) The tissue cutting device of claim 1 wherein said cutting edge is an inwardly beveled surface.

5 ~~17~~. (Original) The tissue cutting device of claim ~~16~~⁴ further comprising a dimple in an inner surface of said outer cannula immediately proximal to said tissue-receiving opening, said dimple sized to fit between said inner cannula and said outer cannula.

6 ~~18~~. (Original) The tissue cutting device of claim 1 further comprising a handpiece removably engageable to said outer cannula and supporting said inner cannula, said first hydraulic rotary motor, and said second hydraulic reciprocating motor.

6 ~~19~~. (Currently Amended) The tissue cutting device of ~~claim 18~~¹⁸ ~~claim 18~~¹⁸ further comprising a collection trap removably mountable to said handpiece and in communication with said proximal end of said inner lumen.

C16 ~~20~~. (Original) The tissue cutting device of claim ~~19~~⁷ wherein said collection trap includes a filter element disposed within said collection trap.

~~21~~. (Original) The tissue cutting device of claim ~~19~~⁷ further comprising a vacuum source in fluid communication with said collection trap to aspirate tissue through said inner lumen into said collection trap.

10 ~~22~~. (Original) The tissue cutting device of claim ~~18~~⁶ further comprising a cover removably engageable to and enclosing said handpiece.

11 ~~23~~. (Original) The tissue cutting device of claim ~~22~~¹⁰ wherein said cover includes:

at least one tang projecting inwardly from an inner surface thereof; and

said handpiece defines at least one engagement notch configured for receiving a corresponding one of said at least one tang for engaging said cover to said handpiece.

¹²~~24~~. (Currently Amended) The tissue cutting device of claim 1 wherein said outer cannula further includes a stiffening element along a length thereof for increasing ~~[[the]]~~^a bending resistance of said outer cannula.

¹³~~25~~. (Original) The tissue cutting device of claim ¹²~~24~~ wherein said stiffening element includes a longitudinally extending rib defined in an outer surface of said outer cannula.

¹⁴~~26~~. (Original) The tissue cutting device of claim ¹²~~24~~ wherein said stiffening element is substantially diametrically opposite the tissue-receiving opening.

¹⁴~~27~~. (Withdrawn) The tissue cutting device of claim ¹³~~25~~ wherein said rib includes a bead adhered to a surface of said outer cannula.

C16 ¹⁵~~28~~. (Original) The tissue cutting device of claim ¹³~~25~~ wherein said rib includes a crimp in said outer cannula.

¹⁷~~29~~. (Withdrawn) The tissue cutting device of claim ¹²~~24~~ wherein said stiffening element includes a layer of rigid material bonded to a surface of said outer cannula.

¹⁸~~30~~. (Withdrawn) The tissue cutting device of claim ¹⁷~~29~~ wherein said material is stainless steel.

¹⁹~~31~~. (Original) The tissue cutting device of claim 1 further comprising a vacuum source in fluid communication with said inner lumen at said proximal end of said inner cannula to aspirate tissue through said inner lumen.

²⁰~~32~~. (Withdrawn) The tissue cutting device of claim 1 further comprising:

an irrigation lumen in fluid communication with said outer lumen; and

a source of irrigation fluid in communication with said irrigation lumen.

²¹₃₃. (Withdrawn) The tissue cutting device of claim ²⁰₃₂ wherein said source of fluid includes an anesthetic fluid.

²²₃₄. (Currently Amended) The tissue cutting device of claim 1 further comprising a dimple in an inner surface of said outer cannula immediately proximal to said ~~tissue-receiving~~tissue-receiving opening, said dimple sized to fit between said inner cannula and said outer cannula.

²³₃₅. (Currently Amended) The tissue cutting device of ~~claim 1~~claim 1 wherein said tissue-receiving opening includes a pair of opposite sides extending longitudinally along said outer cannula, at least one of said opposite sides defining at least one tooth arranged to engage tissue drawn into said opening when said cannula is inserted into a body.

C16 ²⁴₃₆. (Original) The tissue cutting device of claim ²³₃₅ wherein at least one of said opposite sides defines a plurality of teeth, said teeth angled proximally away from said distal end of said outer cannula.

²⁵₃₇. (Original) The tissue cutting device of claim ²³₃₅ wherein each of said opposite sides defines a plurality of teeth, said teeth angled proximally away from said distal end of said outer cannula.

²⁶₃₈. (Original) The tissue cutting device of claim 1 further comprising a trocar tip having an engagement hub configured to fit tightly within said distal end of said outer cannula.

²⁷₃₉. (Withdrawn) The tissue cutting device of claim ²⁶₃₈ further comprising a cutting board disposed within said outer lumen affixed to said engagement hub.

²⁸₄₀. (Original) The tissue cutting device of claim 1 further comprising:

a tubular axle having a distal end and a proximal end; and

a coupler connecting said distal end of said tubular axle to said proximal end of said inner cannula,

wherein said first hydraulic rotary motor is coupled to said tubular axle to rotate said axle and said inner cannula therewith.

²⁸
29 41. (Currently Amended) The tissue cutting device of claim 40 wherein said first hydraulic rotary motor includes:

a motor housing having opposite ends and defining a pilot port in fluid communication with said hydraulic system to receive said pressurized fluid;

a rotor rotatably disposed within said housing and connected to said axle extending through said housing; and

C 16 bearing surfaces at said opposite ends of said housing for rotatably supporting said axle.

²⁹
30 42. (Currently Amended) The tissue cutting device of claim 41 wherein said second hydraulic reciprocating motor includes:

a hydraulic cylinder having a second pilot port in fluid ~~connection~~ communication with said hydraulic system to receive said pressurized fluid;

a piston slidably disposed within said cylinder; and

a hollow tube in fluid communication with said proximal end of said ~~hollow~~ tubular axle,

said tube engaged to said piston and operably coupled to said first hydraulic rotary motor to move said first hydraulic rotary motor as said piston slides within said cylinder.

³⁰
31 43. (Currently Amended) The tissue cutting device of claim 42 wherein said second hydraulic reciprocating motor further includes:

a return spring disposed within said cylinder and biased against said piston to move said piston, said housing and said inner cannula in a direction away from distal end of said outer cannula.

³²44. (Original) The tissue cutting device of claim ³¹~~43~~ further comprising:

a collection trap in fluid communication with said hollow tube; and

a vacuum source in fluid communication with said collection trap to aspirate tissue through said inner lumen, said hollow axle and said tube into said collection trap.

C16 ³³45. (Original) The tissue cutting device of claim 1 wherein said second hydraulic reciprocating motor includes:

a hydraulic cylinder having a pilot port in fluid connection with said hydraulic system to receive said pressurized fluid;

a piston disposed within said cylinder and operably coupled to said inner cannula to move said inner cannula within said outer cannula toward said distal end of said outer cannula;

a return spring disposed within said cylinder and biased against said piston to move said piston and said inner cannula within said outer cannula in a direction away from distal end of said outer cannula.

³⁴46. (Withdrawn) The tissue cutting device of claim 1, wherein said hydraulic system includes:

a manual switch disposed between an output line and said source of pressurized fluid, said manual switch operable in a first position to connect said output line to said source, and in a second position to disconnect said output line from said source;

a first pressure actuated switch disposed between said source of pressurized fluid and said first motor, said first switch operable in response to fluid pressure in said output line to connect or disconnect said first motor to/from said source; and

a second pressure actuated switch disposed between said source of pressurized fluid and said second motor, said second switch operable in response to fluid pressure in said output line to connect or disconnect said second motor to/from said source.

³⁴
35 ~~47~~. (Withdrawn) The tissue cutting device of claim ~~46~~, wherein said hydraulic system includes a vacuum source.

C/6
³⁵
36 ~~48~~. (Withdrawn) The tissue cutting device of claim ~~47~~, wherein:

said vacuum source includes a venturi device; and

said hydraulic system includes a third pressure actuated switch disposed between said source of pressurized fluid and said venturi device, and third switch operable in response to fluid pressure in said output line to connect or disconnect said venturi device to/from said source.

³⁴
37 ~~49~~. (Withdrawn) The tissue cutting device of claim ~~46~~, wherein:

said second hydraulic motor includes a hydraulic cylinder having a piston operably coupled to said inner cannula, a hydraulic input connected to said second pressure actuated switch and a return spring disposed within said cylinder and operating on said piston against fluid pressure at said hydraulic input; and

said hydraulic system further includes an oscillating switch disposed between said output line and said second pressure actuated switch, said oscillating switch operable in response to fluid pressure in said hydraulic cylinder to connect or disconnect said hydraulic input to/from said second pressure actuated switch.

50. (Withdrawn) The tissue cutting device of claim 2 wherein said cutting edge is an inwardly beveled surface.

51. (Withdrawn) The tissue cutting device of claim 2 further comprising a trocar tip, said trocar tip having an engagement hub configured to fit tightly within said distal end of said outer cannula.

52. (Withdrawn) The tissue cutting device of claim 51 wherein said cutting board is affixed to said engagement hub of said trocar tip.

53. (Withdrawn) The improvement in a cannula according to claim 3 wherein said tooth is angled proximally away from said distal end of said cannula.

C16 54. (Withdrawn) The improvement in a cannula according to claim 3 wherein each of said edges defines at least one tooth, said tooth angled proximally away from said distal end of cannula.

55. (Withdrawn) The improvement in a cannula according to claim 3 wherein each of said edges defines a plurality of teeth, said teeth proximally angled away from said distal end of cannula.

56. (Withdrawn) The improvement of claim 5 wherein said rib includes a crimp defined in said outer cannula.

57. (Withdrawn) The improvement of claim 5 wherein said rib includes a bead adhered to a said outer cannula.

58. (Withdrawn) The improvement of claim 4 wherein said stiffening member is a layer of rigid material bonded to a surface of said outer cannula.

59. (Withdrawn) The tissue cutting device of claim 9 wherein said means for supporting said first motor includes:

a tubular axle extending through and supporting said first motor, having a distal end operably connected to said proximal end of said inner cannula, and a

proximal end operably coupled to said second motor to move said axle and thereby said first motor and said inner cannula in said second direction.

60. (Withdrawn) The tissue cutting device of claim 9 wherein said first motor is a hydraulic motor.

61. (Withdrawn) The tissue cutting device of claim 9 wherein said first motor is a rotary motor and said first direction is rotational.

62. (Withdrawn) The tissue cutting device of claim 9 wherein said second motor is a linear motor and said second direction is reciprocation toward and away from said distal end of said outer cannula.

63. (Withdrawn) The tissue cutting device of claim 62 wherein said second motor is a hydraulic motor.

C14 64. (Withdrawn) The tissue cutting device of claim 63 wherein said second motor includes:

a hydraulic cylinder having a pilot port in fluid connection with a hydraulic system to receive a pressurized fluid;

a piston disposed within said cylinder and operably coupled to said inner cannula to move said inner cannula within said outer cannula toward said distal end of said outer cannula;

a return spring disposed with said cylinder and biased against said piston to move said piston and said inner cannula within said outer cannula away from distal end of said outer cannula.

65. (Withdrawn) The tissue cutting device of claim 10 wherein:
said proximal end of said hub defines a mating flange; and
said handpiece defines a fitting configured for removable engagement with said mating flange.

66. (Withdrawn) The tissue cutting device of claim 10 further comprising a radio-opaque marker disposed within said outer cannula.

67. (Withdrawn) The tissue cutting device of claim 11 wherein said handpiece includes a housing having a distal end defining a fitting; and

said hub defines a mating flange at said proximal end, said mating flange engageable to said fitting to connect said handpiece to said hub.

68. (Withdrawn) The tissue cutting device of claim 67 wherein said leak path is defined between said housing and said hub.

C16 69. (Withdrawn) The tissue cutting device of claim 13 further comprising a pressure switch coupled to said source of pressurized fluid to switch from providing pressurized fluid to said motor to permitting fluid to bleed from said motor.

70. (Withdrawn) The tissue cutting device comprising:
an outer cannula defining an outer lumen and a tissue-receiving opening adjacent a distal end of said outer cannula communicating with said outer lumen;

an inner cannula slidably disposed within said outer lumen and defining a inner lumen from an open distal end to an open opposite proximal end, said inner cannula defining a cutting edge at said open distal end operable to sever tissue projecting through said tissue-receiving opening; and

a drive mechanism operably coupled to said inner cannula to move said inner cannula relative to said tissue-receiving opening in said outer cannula, wherein said drive mechanism is substantially composed of a non-metallic material.

71. (Withdrawn) The tissue cutting device of claim 70, wherein said drive mechanism includes:

a first motor operable to rotate said inner cannula; and

a second motor operable to translate said inner cannula.

72. (Withdrawn) The tissue cutting device of claim 71, wherein said first and second motors are hydraulic motors.

73. (Withdrawn) The tissue cutting device of claim 70, wherein said non-metallic material is a plastic.

74. (Withdrawn) The tissue cutting device of claim 70, further comprising a handpiece supporting said drive mechanism and said outer cannula.

75. (Withdrawn) The tissue cutting mechanism of claim 74, wherein said handpiece is substantially composed of non-metallic material.

C16 76. (Withdrawn) The tissue cutting mechanism of claim 75, wherein said handpiece is substantially composed of a plastic material.

77. (Withdrawn) The tissue cutting device of claim 75, wherein said hydraulic system includes said vacuum source.

78. (Withdrawn) The tissue cutting device of claim 77, wherein said vacuum source includes a venturi device.

79. (Withdrawn) An automated method for removing tissue from a patient comprising the steps of:

introducing a tissue removal device into the patient adjacent the tissue removal site, the tissue removal device including an outer cannula defining a tissue-receiving opening, an inner cannula moveably disposed within the outer cannula and defining a lumen from an open distal end to an open opposite proximal end, and a collection trap for storing excised tissue, the tissue removal device operable to sever tissue projecting through the tissue-receiving opening and to aspirate the excised tissue through the lumen into the collection trap;

providing the tissue removal device in communication with a control system, the control system operable to control excision, aspiration and storage of a tissue sample in response to a single authorization step; and

authorizing the control system to remove a tissue sample.

80. (Withdrawn) The method of claim 79, wherein the authorization step comprises actuating a single switch.

81. (Withdrawn) A method for removing tissue from a patient comprising the steps of:

providing a tissue removal device that includes an outer cannula defining at tissue receiving opening, an inner cannula moveably disposed within the outer cannula and defining a lumen from an open distal end to an open opposite proximal end, the inner cannula operable to sever tissue projecting through the tissue-receiving opening;

providing a magnetic resonance imaging device to create an image of the target tissue to be removed;

introducing the outer cannula into the patient with the tissue receiving opening adjacent the tissue removal site; and

simultaneously creating an image of the target tissue using the magnetic resonance imaging device and operating the tissue removal device to remove the target tissue through the tissue receiving opening.

82. (Withdrawn) A method for removing tissue from a patient comprising the steps of:

providing a tissue removal device that includes an outer cannula defining a tissue-receiving opening, an inner cannula moveably disposed within the outer cannula and defining a lumen from an open distal end to an open opposite proximal end, and a collection trap, the inner cannula operable to sever tissue

projecting through the tissue-receiving opening and to direct the excised tissue toward the storage unit;

introducing the outer cannula into the patient with the tissue receiving opening adjacent the tissue removal site;

operating the tissue removal device to excise a tissue sample through the tissue receiving opening;

continuously applying an aspirating vacuum during operation of the tissue removal device to draw the excised tissue through the lumen into the collection trap; and

storing the excised tissue in the collection trap for subsequent examination.

83. (Withdrawn) The method of claim 82, wherein the step of continuously applying the aspirating vacuum is further defined by drawing the tissue sample into the tissue receiving opening using the aspirating vacuum prior to excising the tissue sample.

84. (Withdrawn) The method of claim 82, further comprising the step of operating the tissue removal device to excise at least one additional tissue sample prior to removing the stored excised tissue from the collection trap.